Grower Practices System Promotes Beet Quality Improvement in the Red River Valley

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INTRODUCTION

The Agriculture Department of American Crystal Sugar Company maintains crop production records on each grower field contract in order to monitor agronomic practices that affect the yield and quality of sugarbeets. A study of crop records, to determine what happened and why it happened, helps us to make sound recommendations to our growers for improving beet quality, thus increasing the amount of sugar that can be recovered and sold.

With the advent of the quality payment system in 1980, which bases the individual grower beet payment on recoverable sugar per ton, it became apparent that we needed a record system that could handle a vast amount of data fast and accurately. The Company's main frame computer, Burroughs Model 2930 and the Honeywell Level 6, Models 43 and 47 at the five factory locations, provided this capability. Data from the grower production practices on individual field contracts could now be matched to other information that included the quality lab data and scale weight data used to calculate the beet payment for those contracts. The amalgamation of various data for crop analysis is called the Grower Practices System.

The grower and the agriculturist are the key people in making the Grower Practices System a useful and successful program. The grower provides the field information and the agriuclturist records and prepares the information for encoding into the computer. Special

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provisions are taken in insure that the information used in the program is accurate.

1. Each field must be written as a separate contract.
2. All fields must be accurately measured.
3. All beet deliveries must be credited to the correct contract.
4. Information on agronomic practices must be correct

For the purpose of this paper, a brief summary of crop records includes: 1. Grower Practices Reporting Form; 2. Grower Field Report; 3. Grower Five-Year History Report; 4. Yield and Quality Results By Nitrate Grade, and 5. Beet Quality Analyses In Relation To Plant Nutrition Research.

Grower Practices Form

The grower practices information sheet (Figure 1) and codes (Figure 2) are attached to the annual contract. Some information is collected at contracting and other crop information is collected during the growing season. Attached is a completed sample form for an individual field contract and the final grower field report and a five-year history report.

Grower Field Report

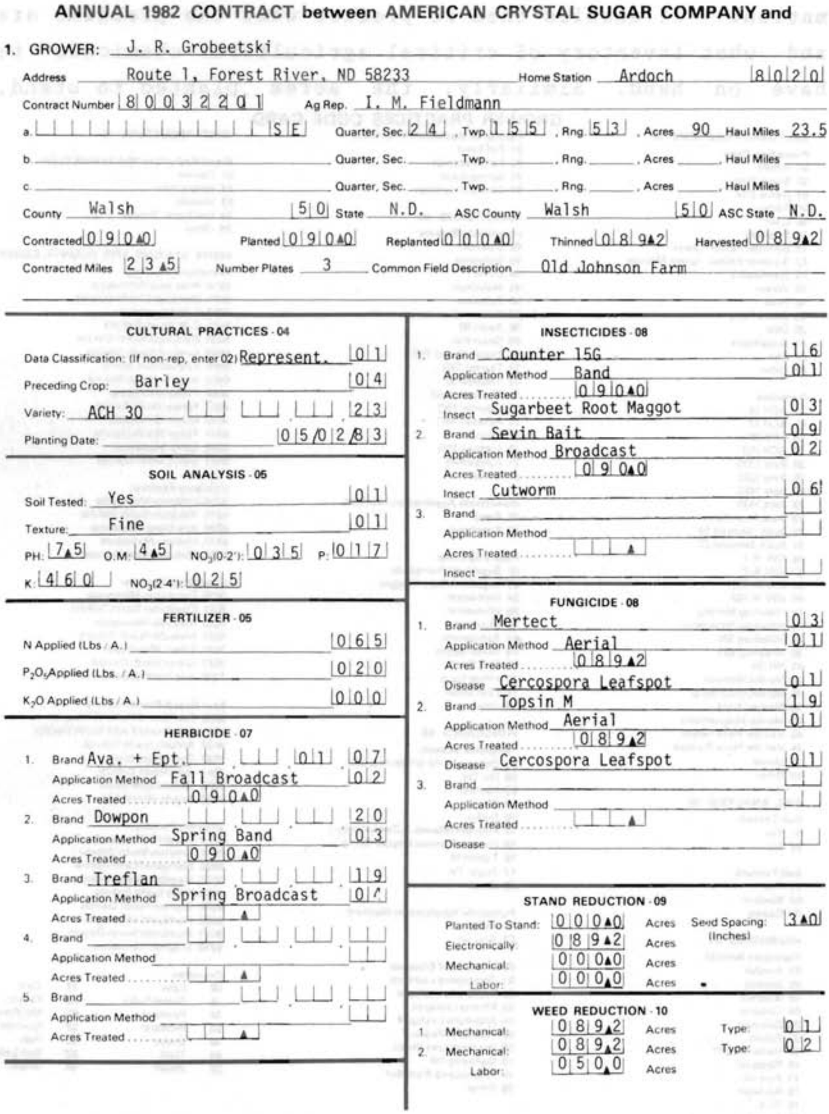
The grower field report (Figure 3) shows the yield and quality results for the individual field contract and can be compared with the results of the grower's total fields, delivery station, factory district, and the Red River Valley. This report is given to the grower by the agriculturist and is discussed when contracting for the next year's crop.

Five Year History

A crop history report (Figure 4) for each grower is maintained beginning with the 1980 crop, the first year of the quality payment system. Eventually a five-year crop history will be maintained for each Crystal grower. This report can be useful in determining fertilizer rates based on realistic yield goals. It also shows what progress, if any, has been made in improving beet quality.

Acerage Usage Reports

Usage reports of herbicides, insecticides, fungicides,



ANNUAL 1982 CONTRACT between AMERICAN CRYSTAL SUGAR COMPANY and

1. GROWER: J. R. Grobeetski

Address Route 1, Forest River, ND 58233 Home Station Ardoch 8 0 2 0

Contract Number 8 0 0 3 2 2 0 1 Ag Rep. I. M. Fieldmann

a. S E Quarter, Sec. 2 4, Twp. 1 5 5, Rng. 5 3, Acres 90 Haul Miles 23.5

b. Quarter, Sec. Twp. Rng. Acres Haul Miles

c. Quarter, Sec. Twp. Rng. Acres Haul Miles

County Walsh 5 0 State N.D. ASC County Walsh 5 0 ASC State N.D.

Contracted 0 9 0 ▲0 Planted 0 9 0 ▲0 Replanted 0 0 0 ▲0 Thinned 0 8 9 ▲2 Harvested 0 8 9 ▲2

Contracted Miles 2 3 ▲5 Number Plates 3 Common Field Description Old Johnson Farm

CULTURAL PRACTICES - 04

Data Classification: (If non-rep, enter 02) Represent. 0 1

Preceding Crop: Barley 0 4

Variety: ACH 30 2 3

Planting Date: 0 5 /0 2 /8 3

SOIL ANALYSIS - 05

Soil Tested: Yes 0 1

Texture: Fine 0 1

PH: 7▲5 O.M. 4▲5 NO_3(0-2'): 0 3 5 P: 0 1 7

K: 4 6 0 NO_3(2-4'): 0 2 5

FERTILIZER - 05

N Applied (Lbs / A.) 0 6 5

P_2O_5 Applied (Lbs. / A.) 0 2 0

K_2O Applied (Lbs / A.) 0 0 0

HERBICIDE - 07

1. Brand Ava. + Ept. 0 1 0 7
Application Method Fall Broadcast 0 2
Acres Treated 0 9 0 ▲0

2. Brand Dowpon 2 0
Application Method Spring Band 0 3
Acres Treated 0 9 0 ▲0

3. Brand Treflan 1 9
Application Method Spring Broadcast 0 1
Acres Treated ▲

4. Brand
Application Method
Acres Treated ▲

5. Brand
Application Method
Acres Treated ▲

INSECTICIDES - 08

1. Brand Counter 15G 1 6
Application Method Band 0 1
Acres Treated 0 9 0 ▲0
Insect Sugarbeet Root Maggot 0 3

2. Brand Sevin Bait 0 9
Application Method Broadcast 0 2
Acres Treated 0 9 0 ▲0
Insect Cutworm 0 6

3. Brand
Application Method
Acres Treated ▲
Insect

FUNGICIDE - 08

1. Brand Mertect 0 3
Application Method Aerial 0 1
Acres Treated 0 8 9 ▲2
Disease Cercospora Leafspot 0 1

2. Brand Topsin M 1 9
Application Method Aerial 0 1
Acres Treated 0 8 9 ▲2
Disease Cercospora Leafspot 0 1

3. Brand
Application Method
Acres Treated ▲
Disease

STAND REDUCTION - 09

Planted To Stand: 0 0 0 ▲0 Acres Seed Spacing: (Inches) 3 ▲0
Electronically: 0 8 9 ▲2 Acres
Mechanical: 0 0 0 ▲0 Acres
Labor: 0 0 0 ▲0 Acres

WEED REDUCTION - 10

1. Mechanical: 0 8 9 ▲2 Acres Type: 0 1
2. Mechanical: 0 8 9 ▲2 Acres Type: 0 2
Labor: 0 5 0 ▲0 Acres

Figure 1. Annual 1982 contact between American Crystal Sugar Company and growers.

and acres planted to stand, thinned by machine or hand labor, are compiled from individual field contracts. These reports show trends in chemical use and indicates what weed, insect, or disease problem is prevalent. Chemical suppliers frequently request this type of information. It enables them to predict what the problems are and what inventory of critical agricultural chemicals to have on hand. Similarly, the acres planted to stand,

GROWER PRACTICES CODE CARD

CULTURAL PRACTICES - 04

Preceding Crop:
01 Alfalfa
02 Beans Pinto
03 Beans Soy
04 Barley
05 Corn
10 Potatoes
11 Summer Fallow - Black
12 Summer Fallow - Green Manure
13 Sunflowers
15 Wheat
18 Peas
19 Beans Navy
20 Oats
21 Sugarbeets
22 Flax
99 Other

Varieties:
21 ACH 14
01 ACH 17
23 ACH 30
38 ACH 153
39 Beta 1230
25 Beta 1237
08 Beta 1443
29 Beta 1839
19 Bush Monofort
32 Bush Johnson 19
31 Bush Johnson 27
24 GW R-1
27 GW R-2
33 GW R-105
40 GW R-107
14 Hilleshog Monika
13 Hilleshog Monoricca
28 Hilleshog 309
30 Hilleshog 833
41 HH-30
34 Maribo Monova
35 Maribo Ultramono
36 Maribo Unica
42 Maribo Magnamono
43 Van der Have H6608
44 Van der Have Puressa
16 Mixed
99 Other

SOIL ANALYSIS - 05

Soil Tested:
01 Yes
02 No

Soil Texture:
01 Fine
02 Medium
03 Coarse

HERBICIDES - 07

Herbicide Brands:
01 Avadex
02 Betanal
03 Betanex
04 Carbyne
05 Dowpon
07 Eptam
09 Herbicide 273
10 Paraquat
11 Pyramin
15 Ro-Neet
16 TCA
17 Nortron
19 Treflan
20 Betanix
21 Antor
99 Other

Herbicide Application Method:
01 Fall Band
02 Fall Broadcast
03 Spring Band
04 Spring Broadcast

INSECTICIDES - 08

Insecticide Brands:
02 Diazinon
03 Dyfonate
04 Dylox
05 Malathion
06 Parathion
07 Sevinmol
08 Sevin 80
09 Sevin Bait
10 Temik 10 and 15G
11 Thimet 10G
12 Thiodan 50
15 Thimet Liquid
16 Counter 15G
17 Furadan 10G
18 Lannate
19 Lorsban 15G
21 Lorsban 4E
99 Other

Insecticide Application Method:
01 Band
02 Broadcast

Insect Species:
01 Sugarbeet Nematode
03 Sugarbeet Root Maggot
04 Webworm
05 Wireworm
06 Cutworm
07 Armyworm
09 Grasshopper
12 Flea Beetle
13 White Grub
14 Leaf Miner
99 Other

FUNGICIDES - 08

Fungicide Brands:
01 Dithane M-45 & Manzate 200
02 Du-Ter
03 Mertect
04 Benlate
05 Sulfur
12 Polyram (Maneb & Zineb Comp.)
15 Copper (Various Copper Comp.)
16 Topsin M
17 Super Tin
99 Other

Fungicide Application Method:
01 Aerial
02 Ground

Root and Leaf Disease:
01 Cercospora Leafspot
02 Ramularia Leafspot
03 Phoma Leafspot
04 Alternaria Leafspot
05 Powdery Mildew
08 Bacterial Leaf Blight
13 Damping Off
14 Rhizoctonia Root Rot
99 Other

WEED REDUCTION - 10

Weed Reduction Mechanical Type:
01 Harrow
02 Rotary Hoe
03 Weeder
04 Electronic Zapper
99 Other

HOME STATION AND COUNTY CODES

Moorhead Factory:
6010 Moorhead Minnesota
6011 Moorhead North Dakota
6020 C-W Minnesota
6021 C-W North Dakota
6030 Dalrymple North Dakota
6040 Kindred North Dakota
6041 Kindred Minnesota
6050 Amenia North Dakota
6060 Perley Minnesota
6061 Perley North Dakota
6070 Felton Minnesota
6071 Felton North Dakota
6080 Sabin Minnesota
6081 Sabin North Dakota

Hillsboro Factory:
6510 Hillsboro Minnesota
6511 Hillsboro North Dakota
6530 Ada West Minnesota
6570 Midway Minnesota
6571 Midway North Dakota

Crookston Factory:
7010 Crookston Minnesota
7011 Crookston North Dakota
7020 Nielsville Minnesota
7021 Nielsville North Dakota
7030 Eldred Minnesota
7031 Eldred North Dakota
7050 Ada North Minnesota

East Grand Forks Factory:
8010 East Grand Forks Minnesota
8011 East Grand Forks North Dakota
8020 Ardoch North Dakota
8040 Oslo Minnesota
8041 Oslo North Dakota
8050 Warren Minnesota
8060 Argyle Minnesota

Drayton Factory:
9010 Drayton Minnesota
9011 Drayton North Dakota
9020 Bathgate North Dakota
9030 Hamilton North Dakota
9040 Nash North Dakota
9050 Grafton North Dakota
9060 Humboldt Minnesota
9061 Humboldt North Dakota
9070 Stephen Minnesota

Counties:

09	Cass	14	Clay
18	Grand Forks	35	Kittson
34	Pembina	45	Marshall
39	Richland	54	Norman
46	Steele	60	Polk
49	Traill	63	Red Lake
50	Walsh	84	Wilkin

Figure 2. Grower practices code card.

thinned by machine or labor idcts future trends. With more acres planted to stand or machine thinned, there will be a continuing need for good preemergence and post-emergence herbicides.

AMERICAN CRYSTAL SUGAR COMPANY
1982 GROWER FIELD REPORT

Grower: J. R. Grobeetski — Ag Rep: I. M. Fieldmann
Contract Nbr: 80-0322-01
Land Desc: SE Qtr, Sec. 24, Twp. 155, Range 53

AVERAGE

Contracted	Planted	Replanted	Thinned	Harvested
90.0	90.0	.0	89.2	89.2

YIELD AND QUALITY DATA

Descr.	Field	Grower Total	Station Ardoch	Factory E. Grand Forks-A	Valley
Net Tons	1,599.19	1,599.19			
Beet Ton/Acres	17.9	17.9	18.7	16.5	17.3
Sugar Content	17.211	17.211	15.857	15.768	16.042
Sodium	325	325	676	613	557
Potassium	2501	2501	2542	2400	2367
Amino N	315	315	571	594	628
Sugar Loss Mol.	1.416	1.416	1.929	1.880	1.886
Recoverable Sugar					
Per Ton	316	316	279	278	283
Per Acre	5656	5656	5217	4587	4896
Est Thin Juice Pur	94.80	94.90	92.50	92.64	92.73
Dirt Tare	7.173	7.173	5.789	6.119	5.359
Nitrate Grade	3.2	3.2	4.5	4.3	4.0

Cultural Practices	Soil Analysis		Applied Fertilizer	
Data Class: Representative	Soil Texture:	Fine	N:	65
Preceding Crop: Barley	PH:	7.5	P205:	20
Planting Date: 05/02/82	Organic Matter:	4.5	K20:	0
Seed Variety: ACH 30	NO_3- 0-2 Feet:	35		
	Phosphorus:	17	Available	
	Potassium	460	Nitrogen	120
	NO_3- 2-4 Feet:	25		

Recommendations:

Figure 3. American Crystal Sugar Company 1982 grower field report.

Grower Practice Reports

Correlation reports can be made from the combined statistics from the individual field contracts. Yield and quality comparisons are available for many grower practices, including the following:

1. Nitrate grade (brei nitrate)
2. Seed variety
3. Planting date
4. Preceding crop
5. Soil test nitrogen levels (0-2') by nitrate grade

6. Soil test nitrogen levels (2-4') by nitrate grade
7. Soil test potassium levels, (low, medium, high, and very high)
8. Soil test phosphorus levels (low, medium, high, and very high)

Only representative field contracts are used in these reports. Representative means that the fields were accurately measured, all loads were credited to the correct contract and agronomic information is correct. The three-year data (1980-1981-1982) represents 85% of the total fields analyzed for yield and quality. Data from nonrepresentative field contracts are not used in any yield or quality analysis.

Yield and quality results from the representative field contracts for various grower practices are available by Agriculturist's area, factory district, and the total Red River Valley. This information has been extremely valuable in formulating sound recommendations to our growers for improving overall beet quality.

Nitrate Grade - Useful In Determining Nitrogen Recommendations

In our crop analysis, fields are separated by nitrate grade (brei nitrate determined in the central beet quali-

Table 1. American Crystal Sugar Company Red River valley three-year average (1980, 1981, 1982).

Nitrate Grade	No. Of Fields	Harvested Acres	Net Tons Harvested	Average Nitrate Grade
2.0 - 2.9	247	15,977.7	282,805	2.6
3.0 - 3.9	1611	107,902.0	1,920,656	3.5
4.0 - 4.9	3655	232,410.6	4,136,909	4.5
5.0 - 5.9	4031	268,579.4	4,700,140	5.3
6.0 - 6.9	430	26,656.3	450,491	6.1
	9974	651,526.0	11,491,001	

Note: 338,346 beet samples were analyzed in the Central Beet Quality Lab during the three-year period.

ty lab). This is a good method of analyzing the nitrogen effects on yield and quality and, also, to determine what level of available nitrogen will produce the most recoverable sugar per ton and per acre. The nitrate content of the beet at harvest is a good indicator of beet quality

AMERICAN CRYSTAL SUGAR COMPANY
1982 5 YEAR GROWER REPORT

Grower: J. R. Grobeetski Ag Rep: I. M. Fieldmann
Contract Nbr: 80-0322

YIELD AND QUALITY DATA

Year:	1982	1981	1980		
Descr.					
Contracted Acres	90.0	90.0	90.0	0.0	0.0
Planted Acres	90.0	90.0	93.6	0.0	0.0
Replanted Acres	0.0	0.0	0.0	0.0	0.0
Thinned Acres	89.2	89.2	86.6	0.0	0.0
Harvested Acres	89.2	89.2	86.6	0.0	0.0
Total Net/Tons	1,599.2	2,374.2	979.7	.0	.0
Beet Ton/Acres	17.9	26.6	11.3	.0	.0
Sugar Content	17.211	15.088	14.806	.000	.000
Sodium	325	912	822	0	0
Potassium	2501	2433	3608	0	0
Amino N	315	703	704	0	0
Sugar Loss Mol	1.416	2.175	2.534	.000	.000
Recoverable Sugar					
Per Ton	316	258	245	0	0
Per Acre	5656	6863	2769	0	0
Est Thin Juice Pur	94.80	91.23	89.76	00	.00
Dirt Tare	7.173	5.006	5.074	.000	.000
Nitrate Grade	3.2	5.2	6.2	.0	.0

Average All Years

Beet Ton/Acre	18.7
Sugar Content	15.728
Sodium	702
Potassium	2686
Amino N	576
Sugar Loss Mol.	1.997
Recoverable Sugar	
Per Ton	275
Per Acre	5143
Est Thin Juice Pur	92.20
Dirt Tare	6.331
Nitrate Grade	4.1

Figure 4. American Crystal Sugar Company 1982 5 year grower report.

and is directly related to the amount of residual nitrogen in the soil and the fertilizer nitrogen applied. The following table shows the number of fields, harvested acres, and net tons in each nitrate grade range.

The nitrate grade is based on a logrithmic scale. A small change in the grade number means a large change in the brei nitrate content. In the following table the approximate nitrate concentration is shown for the average nitrate grade of the five nitrate grade ranges. Note that a nitrate grade of 6.1 has a NO_3 concentration 10 times greater than a low reading of 2.6.

The nitrate concentration in the beet root as expressed by the nitrate grade directly relates to the available nitrogen in the soil at harvest. A low reading of 2.6 indicates that the available nitrogen has been nearly depleted, which is ideal. A high reading indicates

Table 2. Aproximate NO_3 concentration for nitrate grades.

Nitrate Grade	PPM NO_3
2.6	116
3.5	209
4.5	404
5.3	684
6.1	1157

that an excessive amount of nitrogen is still available to the beet. The data in table 3 shows the concentration of sodium, potassium, and amino nitrogen, in the beet root with increasing levels of nitrogen availability.

Table 3. Relation of nitrate grade to impurities in the beet root Red River Valley three-year average (1980, 1981, 1982).

Nitrate Grade	Na	K	am-N	Impurity Value
2.6	330	2209	530	11,724
3.5	441	2317	604	13,086
4.5	615	2522	677	14,892
5.3	809	2677	769	16,832
6.1	1010	2918	801	18,447

The impurities sodium, potassium, and amino nitrogen, are measured as individual elements in the Central Beet Quality Lab. They are associated with other salts and the total amount of impurities and the percent sugar loss to molasses can be calculated using the Carruthers formula. The standard formula developed by Dr. Carruthers, at the British Sugar Corporation, is slightly modified to reflect the measured sugar loss to molasses in Crystal factory operations on a fresh beet basis.

Impurity Value =

(ppm Na x 3.5) + (ppm K x 2.5) + (ppm am-N x 9.5)

$$\text{Percent Sugar loss to Molasses} = \frac{\text{Impurity Value}}{11{,}000} \times 1.5^*$$

As the impurities increase in the beet root, percent sugar decreases and the percent sugar loss to molasses increases. This relationship is shown by nitrate grade in table 4.

Table 4. Relation of nitrate grade to percent sugar and percent sugar loss to molasses Red River Valley three-year average (1980, 1981, 1982).

Nitrate Grade	Percent Sugar	Percent Sugar Loss
2.6	17.0	1.60
3.5	16.5	1.78
4.5	15.8	2.03
5.3	14.9	2.30
6.1	14.1	2.52

Recoverable sugar per ton is calculated by subtracting the percent sugar loss to molasses from the percent sugar and multiplying by 20 hundredweight. Recoverable sugar per acre is calcualted by multiplying the recoverable sugar per ton by the yeild per acre. The data in table 5 are weighted averages of the fields in each nitrate range. Note that the yield per acre remains about the same with increasing nitrogen availability, while recoverable sugar per ton and per acre decreases. Yield per acre at the very high nitrate level of 6.1 is lower and this is propably due to a lower plant population in these fields.

American Crystal's Quality Payment System is based on recoverable sugar per ton on an individual grower contract basis. The sugar loss due to storage and process is subtracted and the payment is then calculated on the recovered sugar per ton. Recovered sugar per ton multiplied by the net selling price of sugar plus by-product revenue minus member business cost is calculated for each grower

*For each one pound of impurities, 1.5 pounds of sugar is lost to molasses.

Table 5. Relation of nitrate grade to root yield and recoverable sugar Red River Valley three-year average (1980, 1981, 1982).

Nitrate Grade	Tons/ Acre	Net Sugar Content*	Pounds Recoverable Sugar	
			Per Ton	Per Acre
2.6	17.7	15.4	308	5479
3.5	17.8	14.7	295	5271
4.5	17.8	13.8	276	4945
5.3	17.5	12.6	253	4454
6.1	16.9	11.6	232	3919

*Percent sugar minus percent sugar loss to molasses (fresh beet basis).

contract. The following table shows the beet payment for the field contracts in each nitrate grade.

Table 6. Relation of nitrate grade to the beet payment Red River Valley three-year average (1980, 1981, 1982).

Nitrate Grade	Beet Payment	
	Per Ton	Per Acre
2.6	$ 38.63	$ 683.75
3.5	35.57	633.15
4.5	31.11	533.76
5.3	25.71	449.93
6.1	20.78	351.18

Table 7. Relation of nitrate grade to soil N, fertilizer N, and total N (0-2') Red River Valley three-year average (1980, 1981, 1982).

No. Of Fields	Nitrate Grade	Lbs/Acre 2' Soil N*	Lbs/Acre Fert. N	Lbs/Acre 2' Total N
247	2.6	62	72	134
1611	3.5	79	66	145
3655	4.5	93	60	153
4031	5.3	109	56	165
430	6.1	111	60	171

*Soil test data represents 61% of the fields soil tested during the three-year period.

The nitrate grade became an important separation in determining nitrogen fertilizer practices that will produce the highest recoverable sugar per tone and per acre. The soil tested fields in each nitrate grade range shown in the above table provides some clues for refining nitrogen recommendations.

These data show a trend towards increasing amounts of residual soil nitrogen in fields with the higher nitrate grades. Fertilizer applications tend to be on the high side and this is reflected in the percent sugar, percent sugar loss to molasses and recoverable sugar shown in tables 4 and 5. The total available nitrogen in the 2.6 nitrate grade comes the closet to Crystal's 1983 nitrogen recommendation of 120 pounds of nitrogen per acre for top yielding high quality beets.

The increments of total nitrogen per acre are relatively small for each nitrate grade range and this does not adequately explain why the beet samples from fields in the 6.1 grade have a nitrate concentration 10 times greater than samples from the fields in the 2.6 grade.

Subsoil nitrogen is another important source of nitrate concentration in the beet root at harvest as expressed by the nitrate grade. A total of 625 fields representing 43,350 acres were tested during the three-year period from 1980 through 1982 for available nitrogen in the 2 to 4 foot soil depth. Although the data represents only 6.6% of the total fields, it does indicate that subsoil nitrogen is definitely an important source contributing to an increase in the nitrate grade.

From the data in table 8, note that the total nitrogen per acre now has a greater spread between nitrate grades, 2.6, 3.5, and 4.5, and this indicates that subsoil nitrogen is definitely contributing to an increase in the brei nitrate concentration. However, the differences in total nitrogen per acre level off with nitrate grades 4.5, 5.3, and 6.1. This indicates that there is an unaccountable source of nitrogen contributing to the brei nitrate concentration. The only other source left would be the nitrogen mineralized from the soil organic matter during the growing season. Red River Valley soils average approximately 5.0% organic matter and the amount mineralized during the growing season could be considerable and is not adequately accounted for in the North Dakota State University nitrogen recommendation for sugarbeets. Colorado

Table 8. Relation between nitrate grade, total nitrogen (4 feet) and yield and quality, Red River Valley three-year average (1980, 1981, 1982).

		Lbs. Per Acre					
Number Fields	Nitrate Grade	Soil + Fert. N 0-2'	Soil N 2-4'*	Total N	Tons/ Acre	% Sugar	% Sugar Loss
247	2.6	134	47	181	17.7	17.0	1.60
1611	3.5	145	59	204	17.8	16.5	1.78
3655	4.5	153	69	222	17.8	15.8	2.03
4031	5.3	165	63	228	17.5	14.9	2.30
403	6.1	171	62	233	16.9	14.1	2.52
9974							

*Limited data - represents 6.6% of the total fields soil tested to 4' during the three-year period.

research indicated that mineralization can be considerably higher in soils that test high in available nitrogen compared to low testing soils. This research also shows that on a pound for pound basis, the soil test nitrogen has a greater effect on sugarbeet yield and quality than the applied fertilizer nitrogen (3).

After a thorough study of our three-year yield and quality data and a thorough review of sugarbeet nitrogen research conducted over the past ten years by North Dakota State University and the University of Minnesota, American Crystal reduced the nitrogen recommendation for the 1983 sugarbeet crop by 30 pounds, from 150 to 120 pounds per acre. The 120 pounds per acre is the total of the soil test nitrogen in the 0-2' depth plus 80% of the soil test nitrogen in the 2-4' depth plus fertilizer nitrogen.

The fastest way to improve sugarbeet quality is to get nitrogen management practices under control. American Crystal will continue to refine the nitrogen recommendation for sugarbeets grown in the Red River Valley, as needed, to produce the highest recoverable sugar per ton and per acre to provide the maximum dollar return to our grower members.

<u>Beet Quality Analyses In Relation To Plant Nutrition Research</u>

It has been established by research studies that high nitrate uptake by the beet root results in an excessive uptake of positively charged ions such as sodium and potassium (6, 7, 9). This relationship is clearly demonstrated in the three-year crop analysis shown in table 3.

It is also generally recognized that potassium uptake will increase with higher soil potassium levels and that a reciprocal relationship exists between potassium and sodium uptake by the beet root. As potassium availability and uptake increase, sodium uptake decreases and vice versa (1, 2, 4, 5, 7, 8). The relationship between potassium uptake and soil potassium levels on high and low nitrogen fields are shown in Figure 5.

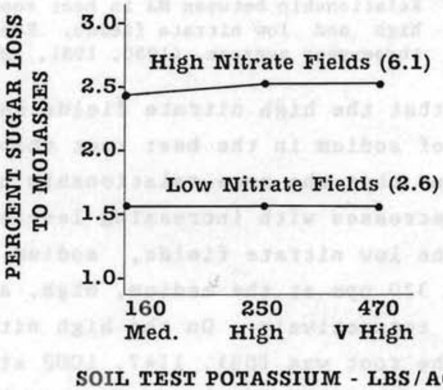


Figure 5. Relationship between K in beet root and soil K on high and low nitrate fields, Red River Valley three-year average, (1980, 1981, 1982).

Potassium concentration in the beet root increases with increasing levels of soil potassium. The increase is acclerated on the high nitrogen fields. On the low nitrate fields, the potassium in the root was 2004, 2129, 2254 ppm at the medium, high, and very high soil K levels, respectively. On the high nitrate field, the potassium in the root was 2595, 2665, 2913 ppm at the medium, high, and very high soil K levels respectively.

Figure 6 shows the relationship between the sodium concentration in the beet root with increasing levels of soil potassium.

Sodium uptake decreases as soil potassium levels in-

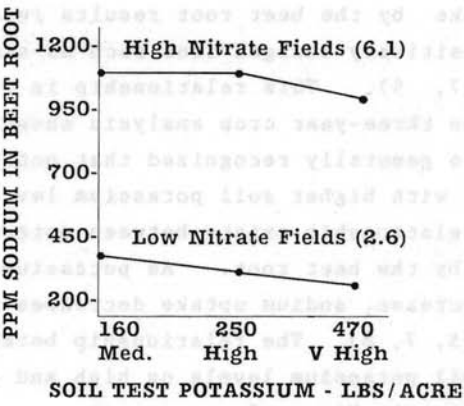


Figure 6. Relationship between Na in beet root and soil K on high and low nitrate fields, Red River Valley three-year average, (1980, 1981, 1982).

crease. Note that the high nitrate fields have a greater concentration of sodium in the beet root than the low nitrate fields and that the same relationship holds true--sodium uptake decreases with increasing levels of soil potassium. On the low nitrate fields, sodium in the root was 386, 337, 320 ppm at the medium, high, and very high soil K levels, respectively. On the high nitrate fields, the sodium in the root was 1081, 1147, 1002 at the medium, high, and very high soil K levels, respectively.

Further proof that the relationship between nitrogen, sodium and potassium exist in the field and are measured in the Central Beet Quality Lab is shown in Figure 7.

The percent sugar loss to molasses remains constant with increasing soil potassium levels. Without research results establishing the reciprocal relationship between sodium and potassium, the reason for equal sugar loss to molasses at each soil K level would be very difficult to explain. On the low nitrate fields, the percent sugar loss to molasses was 1.6 at all soil K levels. On the high nitrate fields, the percent sugar loss to molasses was 2.4 at the medium soil K level and 2.5 at the high and very high soil K levels. The excellent correlation between American Crystal's beet quality analyses, soil fer-

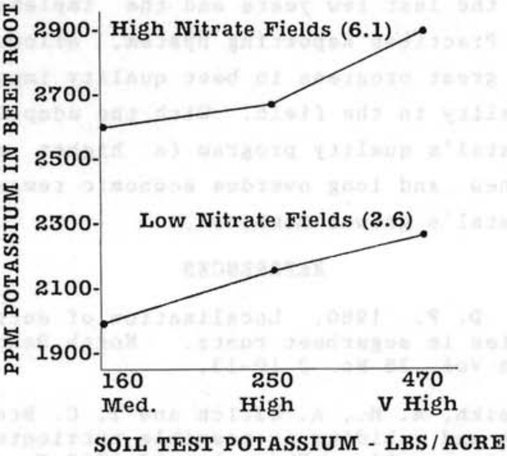


Figure 7. Relationship between percent sugar loss to molasses and soil K level on high and low nitrate fields, Red River Valley three-year average (1980, 1981, 1982).

tility data and proven research results, narrows the cause of an increase in the measured impurities (Na, K and am-N) in the beet root to one source--excessive amounts of available nitrogen.

Nitrogen management is the key to improving beet quality. In our Central Beet Quality Lab, we can now accurately measure the effect of nitrates on sugar content, the accumulation of the impurities (Na, K and am-N) in the root and the consequent sugar loss to molasses. The laboratory measurements are accurate and they do show ways to control and improve beet quality. What we need now in the Red River Valley is to more accurately measure the residual soil nitrogen to a depth of four feet, get a better accounting of mineralization from the soil organic matter during the growing season and begin petiole testing to determine the critical period of early season nitrogen requirements. With these measurements we can do a better job of matching the input nitrogen to desired quality standards while still maintaining high root yield.

SUMMARY

The quality analysis technology developed by American

Crystal in the last few years and the implementation of the Grower Practices Reporting System, allows the opportunity for great progress in beet quality improvement to become a reality in the field. With the adoption of Phase II of Crystal's quality program (a higher payment for quality), new and long overdue economic rewards will accure to Crystal's grower members.

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